PROJECT DATA

Altex Technologies Corporation - 02GO12058

Fuel Preprocessor (FPP) for a Solid Oxide Fuel Cell Auxiliary Power Unit

Recipient:	Altex Technologies Corp.	Instrument Number:	DE-FG36-02GO12058
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Subcontractor(s):		B&R Number(s):	ED1906020
		PES Number(s):	02-2140
EERE Program:	Hydrogen, Fuel Cells & Infrastructure Technologies	State Congressional District:	CA - 15

PROJECT SCOPE: The objective of this project is to develop and test a prototype Fuel Preprocessor (FPP) that efficiently and safely converts the diesel fuel into a clean fuel suitable for a SOFC APU system. FPP design will be refined and a prototype unit will be built and tested for a 5 kW SOFC/APU. The technology is projected to save 7800 billion Btu/year energy, save the truck industry 183 million dollar per year and annually reduce CO_2, NOx, and CO by 0.9 million tons, 6,000 tons and 10,080 tons, respectively.

FINANCIAL ASSISTANCE

Approved DOE Budget:	$200,000	Approved DOE Share:	$200,000
Obligated DOE Funds:	$200,000	Cost Share:	$20,000
Remaining Obligation:	$0		
Unpaid Balance:	$64,362	**TOTAL PROJECT:**	**$220,000**

Project Period: 08/01/02 to 07/31/04

TECHNICAL PERFORMANCE
DE-FG36-02GO12058
Altex Technologies Corporation
Fuel Preprocessor (FPP) for a Solid Oxide Fuel Cell Auxiliary Power Unit

PROJECT SYNOPSIS

This project will develop and test a prototype Fuel Preprocessor (FPP) that efficiently and safely converts diesel fuel into a clean fuel suitable for a SOFC APU system. FPP design will be refined and a prototype unit will be built and tested for a 5 kW SOFC/APU. The technology is projected to save 7,800 billion Btu/year energy, save the truck industry 183 million dollars per year and annually reduce CO_2, NOx, and CO by 0.9 million tons, 6,000 tons and 10,080 tons, respectively.

SUMMARY OF TECHNICAL PROGRESS

During the first six months of the project, efforts were focused on understanding the level of sulfur reduction possible in batch modes and the design and fabrication of a continuous FPP unit capable of processing fuel for supplying a 5 kW SOFC unit. For these preliminary tests, the unit was electrically heated. The FPP unit succeeded in reducing fuel sulfur of a commercial diesel fuel by approximately 60-65%.

During the second semi-annual period, improvements were made in the FPP, the FPP runs were automated and other fuels were included as part of the testing. Improvements increased the FPP effectiveness, which was able to reduce as much as 87% of the fuel sulfur. Analyses of the processed fuel from FPP were performed using a Gas Chromatograph purchased by Altex as part of the cost share for this project. These data showed the FPP is also effective in reducing the undesirable polyaromatics. These data were then used to design and partially fabricate an integrated FPP unit, which uses the simulated SOFC exhaust, instead of electric heating, for providing the needed heat to the FPP. During this period, efforts were focused on completing the fabrication of an integrated FPP that has the capability to use simulated SOFC exhaust gas as the heat source. After initial tests with the new FPP, it was determined that the unit is heat transfer limited and some redesign was needed to improve the performance of the unit. After this design modification, the unit was successfully tested with different fuels. Altex also purchased and installed a total sulfur analyzer using Altex funds. This analyzer was used to determine the sulfur concentration of fuel samples that were tested in the fractionator, during this period.

During the third semi-annual reporting period the Integrated FPP was designed and fabricated. During the initial testing two problems were encountered. First, a high system pressure drop developed and second, heat transfer limitations on the outside annular space were found. The high pressure drop problem was due to the rotameter and it was solved by installing a different type of rotameter with low pressure drop. The heat transfer limitation problem was resolved by filling the annulus with copper mesh. The current tests with the new FPP targeted two goals: 1) prove feasibility of using SOFC exhaust gas as heating medium for fractionator, and 2) test the effectiveness of fractionator with a fuel of low initial sulfur.
In general, the FPP's performance has been excellent and has exceeded almost all the specifications and requirements set forth at the beginning of the project.

SUMMARY OF PLANNED WORK

Testing and evaluation will be completed and the potential for integrating the FPP with a reformer and SOFC will also be evaluated.

PROJECT ANALYSIS

The project is making excellent progress and the results to date have been encouraging. The hurdles that have been encountered thus far have been successfully mitigated, and the prototype FPP unit has exceeded the original performance expectations. It is expected that the project will finish by the current end date of 07/31/04 and that no major cost overruns will occur.

ACTION REQUIRED BY DOE HEADQUARTERS

No action is required from DOE Headquarters at this time.

STATEMENT OF WORK
DE-FG36-02GO12058
Altex Technologies Corporation
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DETAILED TASK DESCRIPTIONS

Task 1. FPP Design Refinement

The purpose of this task is to refine the FPP system design.

Subtask 1.1 Process Design
The purpose of Subtask 1.1 is to design the FPP process by performing process calculations.

At the initiation of this task, the FPP system specifications will be defined. In particular, the target fractionator temperature and the level of fractionation will be defined in this task. For this purpose, the SOFC/APU developers will be contacted to collect information on the latest status of the SOFC/APU developments. In particular, inputs from Delphi Automotive, a major developer of the SOFC/APU under the DOE Solid State Energy Conversion (SECA) program will be used to define the needed fractionation level for their system.

After defining the fractionator temperature, process calculations will be performed for a 5 kW FPP/SOFC system. For these calculations, WinSim, an available commercial chemical process module, and Altex Thermo Fluid Model (ATFM) will be used to define the system flows, energy, heat loss, temperatures and pressure drops. These modules are available and are currently being used for the LFPPR design.

Subtask 1.2 Components Design

The purpose of Subtask 1.2 is to design the FPP's components.

Following the process design, the FPP components will be designed. The components include the fractionator, micro-burner, heat exchangers, air cooler and balance of the plant (pumps, fans, valves and controls). The design task will follow procedures and use tools that are being applied in the LFPPR project. The test data generated under the LFPPR program will also be used to define the fractionator internal surface area. The heat transfer calculations and data will be used to define the fractionator external surface area for proper heat transfer.

Based on the process calculations the burner capacity will be defined. This capacity along with the Altex design experinece will be used to design the burner for FPP. In addition, the heat exchangers and the cooling system will also be designed under this subtask, using the available models and data.

Subtask 1.3 Integrated System Design

The purpose of Subtask 1.3 is to produce the integrated FPP design.

The component designs will be integrated together to create the system integrated design. In the integrated system, the air fan, fuel pumps, and controls will be defined. The issues with system startup will also be defined under this subtask.

Task 2. FPP Prototype Design, Fabrication, and Testing

The purpose of this task is to design and fabricate a prototype FPP for laboratory testing and evaluation.

Subtask 2.1 Prototype Design
The purpose of Subtask 2.1 is to translate the Task 1 FPP system design to a prototype FPP for laboratory testing.

Under this subtask the scale of the prototype will be defined. It is anticipated that the prototype system scale to be the same as that of the full-scale system. Therefore, the full-scale design of Task 1 will be used for the prototype system. However, the needed flexibility and instrumentation for testing will be included in the prototype.

Subtask 2.2 Component Fabrication
The purpose of Subtask 2.2 is to fabricate each FPP component.

Initially, the fractionator component will be emphasized to define early on in the program the challenges and issues with this unit. As needed, pre-prototype units will be rapidly fabricated and tested to progressively evolve into the final prototype fractionator.

The prototype burner will be fabricated out of stainless steel. The burner will include a start up device, which will consist of a fuel vaporizer and a piezoelectric igniter. This ignition approach has been demonstrated in Altex bench experiments.

The heat exchanger component will be acquired. It is anticipated that off-the-shelf heat exchangers will be used. If off-the-shelf systems are not available, a unit will be fabricated.

Subtask 2.3 Component Testing
The purpose of Subtask 2.2 is to test each FPP component.

Tests will be planned to define the fractionator performance. The quality of the fractionated light ends will be assessed by analyzing the condensed clean fuel. Outside analytical laboratories will be used for this purpose. Tests will include distillation curves, sulfur analysis and analysis of aromatics. This data will be compared to gasoline sample test results to define the effectiveness of the fractionator in refining diesel fuel to a gasoline-like fuel.

Tests will be planned to demonstrate how the fractionator and the burner operate together. Anticipated tests, to be included in a test plan, are listed in Table 1. Initial tests will focus on proper operation of the micro-burner. For the specified heat load, the burner will be brought to steady operation and measurements of emissions, temperatures and flow rates recorded. As listed in Table 1, once burner/fractionator operation has been found acceptable under standard conditions, several tests will be performed to assess operation under different environments. An available cold chamber will be used to test the burner down to -18C and up to 52C. After the basic performance tests are completed, the burner/fractionator will be operated for over 500 hours and inspected on a periodic basis to note degradation or clogging, and any other component degradation. Output capacity drop off with time and emissions or temperature excursions will be used as a measure of degradation. Also, the system will be disassembled and visually inspected to note any degradation. The heat recovery components will also be tested under this task.

Table 1 - Fractionator and Burner Element and Integrated System Tests

Fractionator Temperature Ranges The fractionator temperature range will be varied to define its effectiveness in fractionating the fuel.
Heat Output and Heat Transfer The fuel flow rate will be measured and compared to the measured heat generation rate, calculated from the load and the exhaust conditions.
Emissions Emissions and O_2 will be measured to define flame quality. Emissions will be compared to the performance goals.
Cold and Hot Temperature Operation The burner will be subjected to temperatures down to –18C (0F) in a cold chamber and up to 52C (125F) in a hot chamber and then tested.
Fuel Flexibility Burner performance will be tested on diesel and fractionated heavy ends.
Consistency of Heat Output Over Time The burner will be tested for its longevity.

Subtask 2.4 Integrated Testing
The purpose of Subtask 2.4 is to test the integrated prototype.

The individual prototype components will be combined for integrated FPP prototype testing. The system will be insulated to minimize heat loss. After integration of the heat recovery components, BOP and insulation, the integrated FPP will be tested as per Table 1 test plan. These will define the FPP efficiency, and its effectiveness to refine diesel to a gasoline like fuel.

Task 3. Performance and Cost Evaluation

The purpose of this task is to evaluate FPP and compare its performance parameters with the goals set at the beginning of the program.

Subtask 3.1 Performance Evaluation
The purpose of Subtask 3.1 is to define the FPP performance.

Under this subtask, the Task 2 test data will be reduced and analyzed to define the FPP effectiveness in removing heavy ends and sulfur from diesel. The quality of the FPP clean fuel will be compared to the gasoline specs to define the effectiveness of the FPP. This evaluation will be performed concurrent to the testing performed under Task 2. The results of this task will be used to optimize the FPP components as needed. The system efficiency, safety flexibility and durability will also be evaluated. Prototype data will also be used to define the system weight and volume.

Subtask 3.2 Economic Evaluation
The purpose of Subtask 3.2 is to define the cost of the FPP and its economic, energy and environmental benefits.

Fabricator and manufacturer inputs will be collected to define the FPP system cost. The cost of the system will be used to define the impact of the FPP on the SOFC/APU system cost. This information will be used to define the economic impact of the FPP/SOFC/APU system on the truck industry. The system energy and environmental benefits will also be defined. This information will generate the needed input for preparing the FPP Business Plan that will be prepared by Altex after the successful conclusion of this project.

Task 4. Project Management and Reporting

The purpose of this task is to apply the necessary resources to manage project tasks and milestones and provide corrective action when needed.

Under this task, Semi-annual Progress Reports and a Final Report will be prepared and submitted to DOE. The Semi-annual Reports will be submitted by every April 30 and October 31. The Final Report will be submitted within 90 days after the project completion date as specified in the agreement. This task also includes other DOE requirements for market assessments, fact sheets, benefits analyses, workshops, etc.

Semiannual reports will cover project status and plans, and highlight any problems and correction strategies. The final report will document the progress made under this project and document the FPP preliminary commercialization plan.

Project Cost Performance in DOE Dollars for Fiscal Year 2003

DE-FG36-02GO12058 Altex Technologies Corp.

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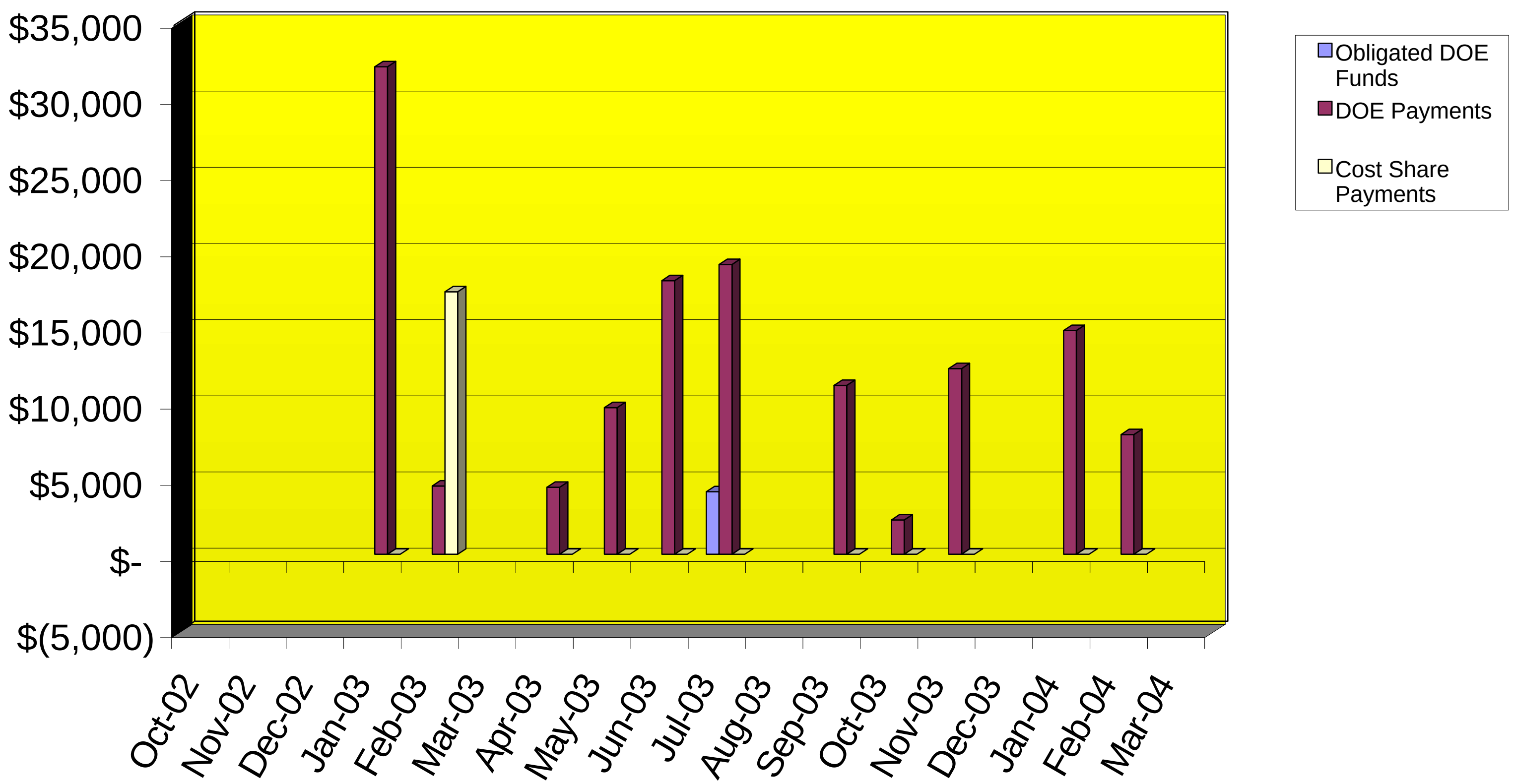

	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03
Obligated DOE Funds	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,119	$0	$0
DOE Payment	$0	$0	$0	$32,010	$4,493	$0	$4,397	$9,632	$17,964	$19,037	$0	$11,084
Cost Share Payment	$0	$0	$0	$0	$17,245	$0	$0	$0	$0	$0	$0	$0

	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	PFY*	Cumulative
Obligated DOE Funds	$0	$0	$0	$0	$0	$0	$195,881	$200,000
DOE Payment	$2,252	$12,198	$0	$14,701	$7,870	$0	$0	$135,638
Cost Share Payment	$0	$0	$0	$0	$0	$0	$0	$17,245

Approved DOE Budget:	$200,000
Approved Cost Share Budget:	$20,000
Total Project Budget:	$220,000

* Prior Fiscal Years

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